THEORETICAL MODELS :

ACHINSTEIN CRITERIA

① SET OF assumptions about Some object or system.

② Attributes an inner structure or Mechanism.

③ Simplified approximations.

④ Proposed in the framework of a theory.

⑤ Displays an Analogy.

MODELS AND ANALOGIES

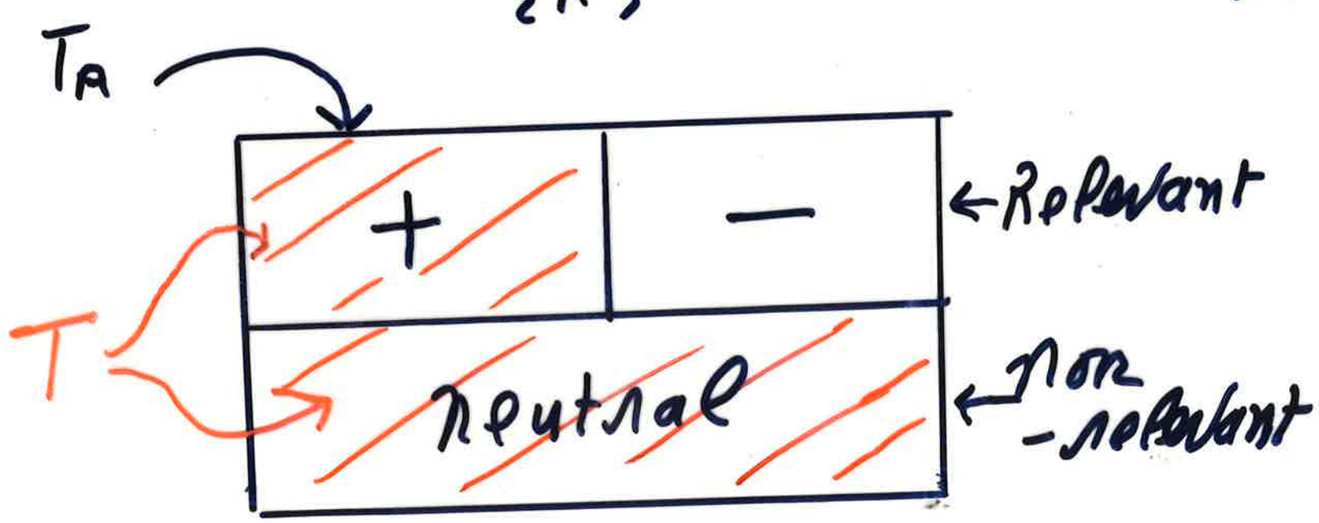
T: $\{P\} = \{R\} \cup \{N\}$

T_M: $\{P'\} = \{R\} \cup \{N'\}$

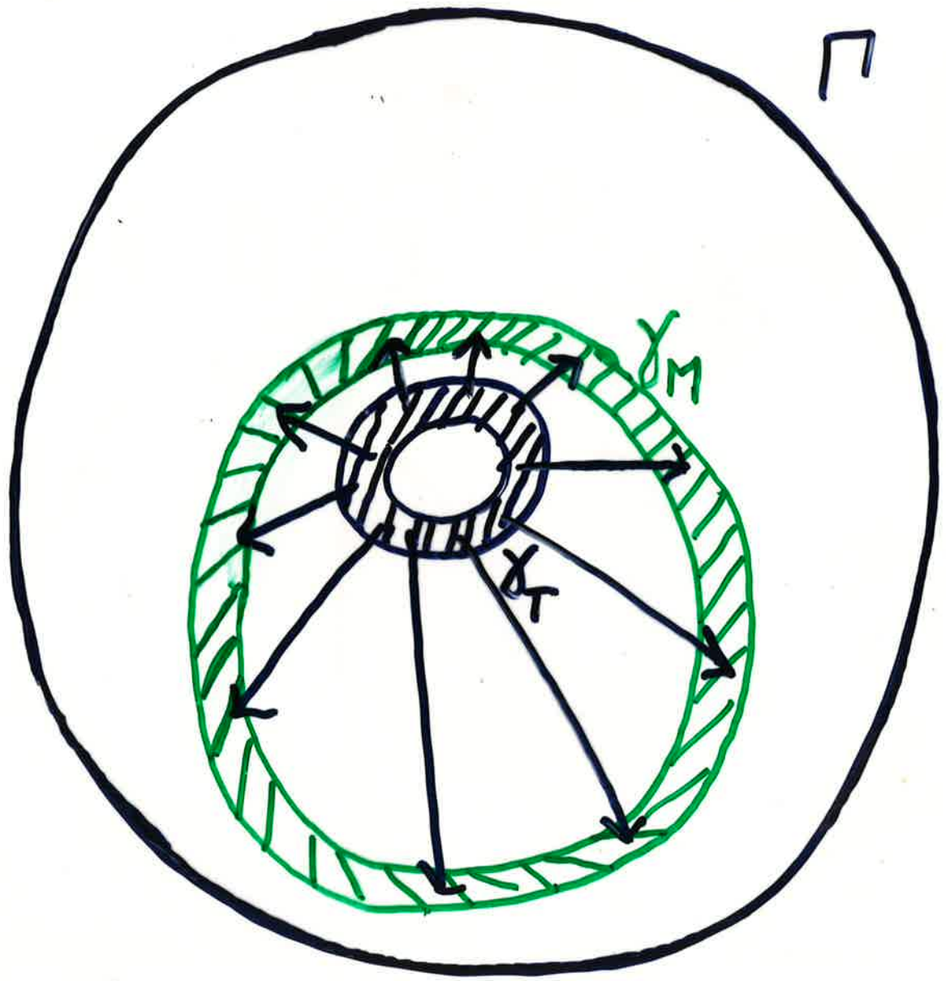
Compare

T_A: $\{P'\} = \{R'\} \cup \{N'\}$

$\{R\}$ relevant for X
$\{R'\}$ " " Y }



MODELS AND APPROXIMATIONS
– GENERAL TREATMENT



MODELS AND APPROXIMATIONS

$$\frac{dy}{dx} - \lambda y = 0, \quad y=1, x=0.$$

For small λ

$$y_n = 1 + \lambda x + \cdots + \frac{\lambda^{n-1} x^{n-1}}{(n-1)!}$$

This is <u>exact</u> solution of

$$\frac{dy}{dx} - \lambda y + \frac{\lambda^n x^{n-1}}{(n-1)!} = 0.$$

PROBING OF THEORIES

$$(1-x)\frac{dy}{dx} = \cos\lambda x + y \quad , \quad \left.\begin{matrix} y=y_1 \\ x=0 \end{matrix}\right\}$$

Power series in x gives

$$y_3 = x + x^2 + (1-\lambda^2/6)x^3 .$$

Small-λ Model

$$(1-x)\, dy/dx = 1 + y$$

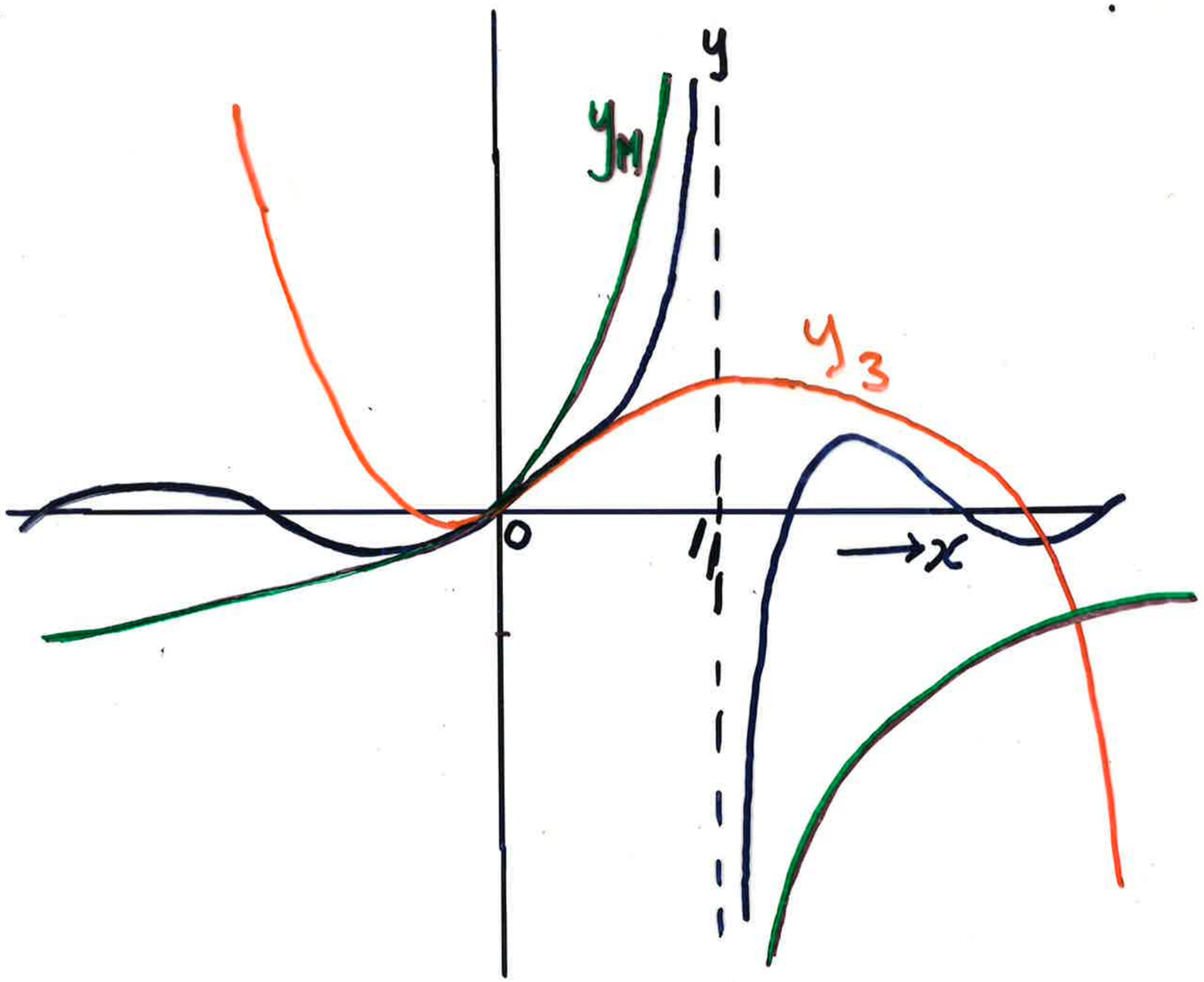
So $\quad y_M = x/1-x$

$$= x + x^2 + x^3 + \cdots$$

Try $\quad y(x) = f(x)/1-x$

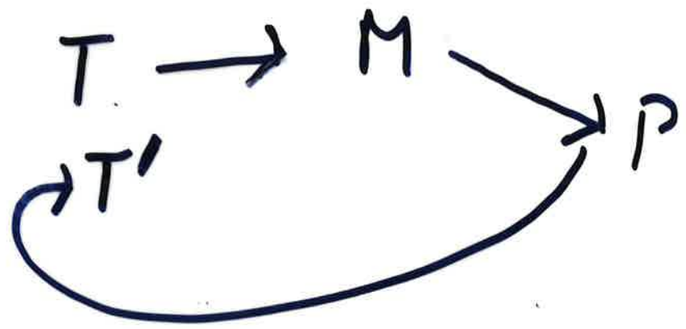
$$\Rightarrow \quad \frac{df}{dx} = \cos\lambda x$$

$$\therefore \quad y = \frac{\sin\lambda x}{\lambda(1-x)}$$

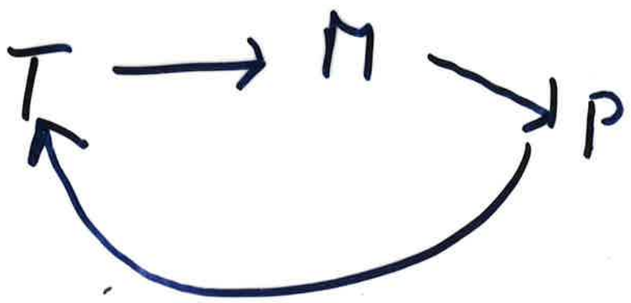

y
y_M
y_3
0
x

HEURISTIC ROLE OF MODELS

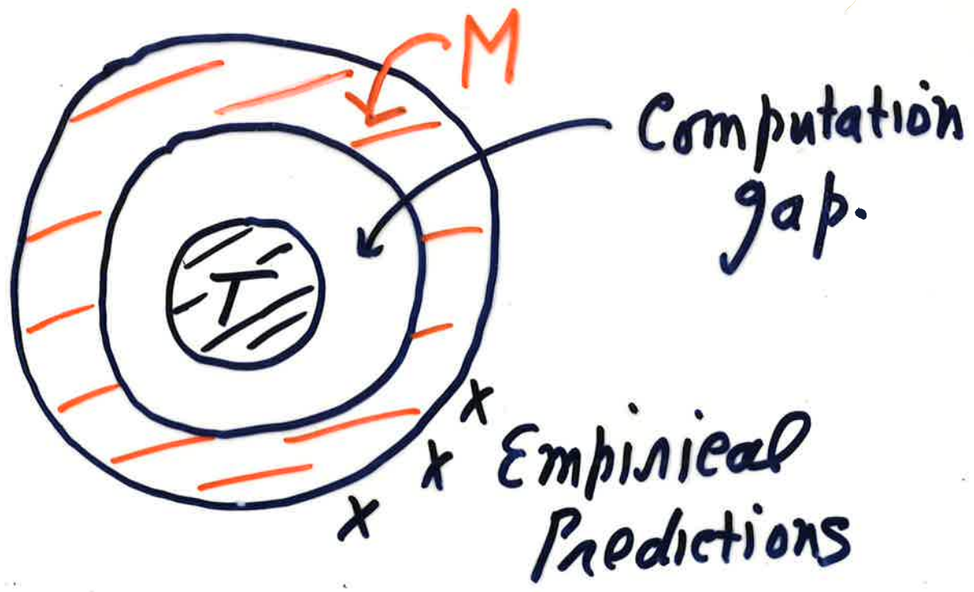
Impoverishment



Enrichment



TESTING OF THEORIES



$M \rightarrow \sim S$

$\underline{\quad S \quad}$

$\sim M$ by modus tollens

But $\sim M \rightarrow \sim (T \wedge A)$

$\leftrightarrow (\sim T) \vee (\sim A)$

COINCIDENCE IN MODEL PREDICTIONS

M_1 M_2 ... predict x_1 x_2 ...

T predicts x

Define errors δ_1, δ_2 ...

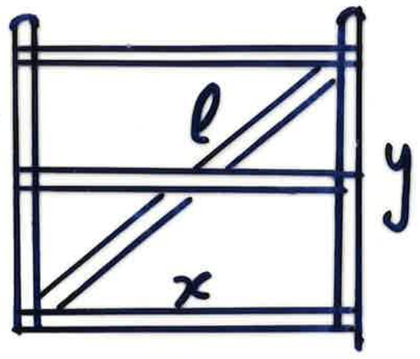
s.t. $x = x_1 + \delta_1 = x_2 + \delta_2 \cdots$

All models adequate $\rightarrow \delta_1 = \delta_2 = \cdots = 0$

$\rightarrow x_1 = x_2 = \cdots (= x)$

Does $x_1 = x_2 = \cdots$ support $\delta_1 = \delta_2 = \cdots = 0$?

FARM GATE CONTRACTION

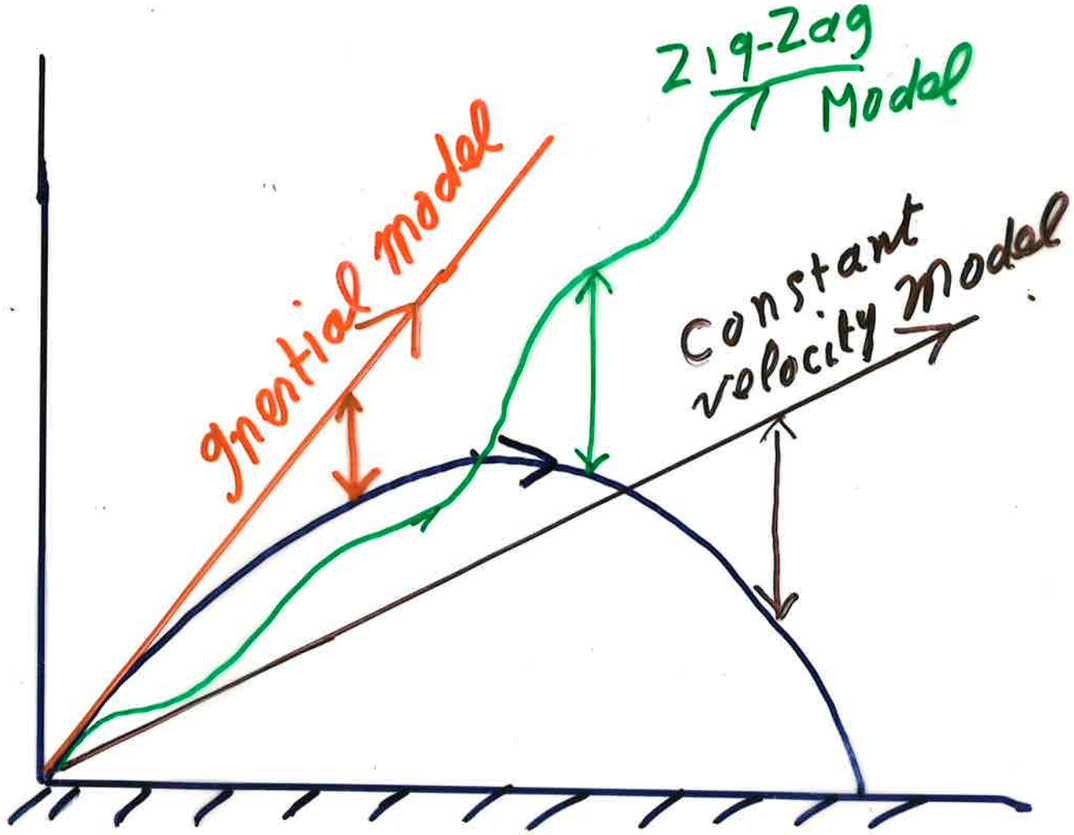


Linear Model:

$$\ell = x + y$$

Cp.

$$\ell = \sqrt{x^2 + y^2}$$

Mismatch explained by Farm Gate Contraction

FLOATING MODELS FOR PROJECTILES